CLAIMS

What is claimed is:

1. An apparatus for preparing a macromolecule sample, comprising:

a hydraulic system adapted for control by an automated controller, comprising a pump and one or more valves;

a rough filter selected to separate from a macromolecule in a liquid mixture, at least a portion of one or more rough components in the mixture that are larger than the macromolecule;

a fine filter selected to separate from the macromolecule, at least a portion of one or more fine components in the mixture that are smaller than the macromolecule; and

the hydraulic system being controlled to apply the liquid mixture to each filter with a pressure differential across each filter.

2. The apparatus of Claim 1, wherein the fine components comprise salt components.

3. The apparatus of Claim 2, further comprising a reservoir supplying a denaturation agent.

4. The apparatus of Claim 3, further comprising a heating element adapted for control by the automated controller.

5. The apparatus of Claim 4, further comprising a cooling element adapted for control by the automated controller.

6. The apparatus of Claim 2, further comprising at least one ionic concentration sensor adapted to communicate with the automated controller.

7. The apparatus of Claim 6, further comprising at least one flow sensor adapted to communicate with the automated controller.

8. The apparatus of Claim 7, wherein the hydraulic system comprises a second pump adapted for control by the automated controller.

9. The apparatus of Claim 8, wherein at least one ionic concentration sensor is a pH sensor.

10. The apparatus of Claim 9, further comprising a reservoir supplying a desalination buffer.

11. The apparatus of Claim 10, further comprising a reservoir supplying a pH buffer.

12. The apparatus of Claim 11, further comprising the automated controller in communication with the valves, the pumps, and the sensors.

13. The apparatus of Claim 2, wherein the molecular weight of the macromolecule is between about 1,000 and about 200,000 AMU.

14. The apparatus of Claim 13, wherein the molecular weight of the macromolecule is between about 10,000 and about 160,000 AMU.

15. The apparatus of Claim 14, wherein the fine filter is selected to separate components of a molecular weight less than about 90% of the molecular weight of the macromolecule.

16. The apparatus of Claim 15, wherein the rough filter is selected to separate components of a molecular weight greater than about 110% of the molecular weight of the macromolecule.

17. The apparatus of Claim 2, further comprising a lysis unit.

18. The apparatus of Claim 17, wherein the lysis unit comprises a sonic disruptor controlled by the automated controller.

19. The apparatus of Claim 17, wherein the lysis unit comprises a pump and a reservoir supplying a lysis buffer.

20. An apparatus for preparing a macromolecule sample, comprising:

a hydraulic system comprising two or more pumps, buffer reservoirs, a flow sensor, a pH sensor, a heating element, and valves;

at least three filters selected to separate from a macromolecule in a liquid mixture, at least a portion of other components in the mixture, the filters including:

a first stage rough filter selected to separate rough components;

a second stage rough filter selected to separate at least a portion of rough components that pass through the first stage rough filter;

a fine filter to separate fine components comprising salt components;

an automated controller in communication with the valves, the pumps, the heating element, and the sensors that controls the hydraulic system to:

apply the liquid mixture to each filter with a pressure differential across each filter;

direct a desalination buffer from a reservoir through the fine filter into the mixture;

combine a denaturation agent from a reservoir with the macromolecule;

control the heating element to heat the combination of the macromolecule and the denaturation agent until at least partial denaturation of the macromolecule occurs; and

combine a pH buffer from a reservoir to maintain a pH value at the pH sensor in a range from 6 to 8.

21. The apparatus of Claim 20, wherein the liquid mixture comprises cells, further comprising a pump that combines a lysis buffer from a reservoir with the cells.

22. A method for preparing a macromolecule sample, comprising:

automatically acquiring a liquid mixture, the mixture comprising a macromolecule, one or more rough components that are larger than the macromolecule, and one or more fine components that are smaller than the macromolecule; and

automatically separating from the macromolecule at least a portion of the components by applying the mixture to each of a plurality of filters, with a pressure differential across each filter, the filters comprising a rough filter selected to separate at least a portion of the rough components and a fine filter selected to separate at least a portion of the fine components.

23. The method of Claim 22, wherein the macromolecule has a molecular weight between about 1,000 and about 200,000 AMU.

24. The method of Claim 23, wherein the fine components comprise salt components.

25. The method of Claim 24, further comprising automatically reducing the concentration of the salt components by at least 50%.

26. The method of Claim 24, further comprising automatically increasing the macromolecule concentration by at least 100%.

27. The method of Claim 26, further comprising automatically reducing the concentration of the salt components by at least 50%.

28. The method of Claim 27, further comprising automatically reducing the concentration of the salt components by at least 75%.

29. The method of Claim 28, further comprising automatically increasing the macromolecule concentration by at least 200%.

30. The method of Claim 24, further comprising automatically controlling the concentration of ions in the mixture by sensing the ion concentration and adding an ion buffer.

31. The method of Claim 30, further comprising automatically directing a desalination buffer through the fine filter into the mixture.

32. The method of Claim 31, further comprising automatically controlling the concentration of hydrogen ion to be in a pH range from 6 to 8 by adding a pH buffer to the mixture.

33. The method of Claim 24, further comprising selecting the rough filter to separate rough components that have a molecular weight greater than about 110% of the molecular weight of the macromolecule.

34. The method of Claim 33, further comprising selecting the fine filter to separate fine components that have a molecular weight less than about 90% of the molecular weight of the macromolecule.

35. The method of Claim 24, further comprising automatically combining the macromolecule with a denaturation agent.

36. The method of Claim 35, wherein the denaturation agent is sodium dodecyl sulfate.

37. The method of Claim 34, further comprising automatically heating the macromolecule until at least partial denaturation occurs.

38. The method of Claim 35, further comprising automatically heating the macromolecule and the denaturation agent until at least partial denaturation of the macromolecule occurs.

39. The method of Claim 38, further comprising automatically heating the macromolecule and the denaturation agent to between from about 70 °C to about 100 °C for about 60 to about 600 seconds.

40. The method of Claim 39, further comprising automatically heating the macromolecule and the denaturation agent to about 90 °C for about 300 seconds.

41. The method of Claim 24, further comprising automatically lysing cells in the liquid mixture.

42. The method of Claim 42, further comprising lysing cells in the liquid mixture by automatically adding a lysis buffer to the cells.

43. The method of Claim 43, further comprising separating the macromolecule from at least a portion of insoluble lysed cell fragments by automatically applying the mixture to a lysis filter with a pressure differential across the filter.

44. A method for preparing a macromolecule sample, comprising automatically:
acquiring a liquid mixture, the mixture comprising a macromolecule of molecular weight between about 10,000 and about 160,000, one or more rough components larger than the macromolecule, and one or more fine components smaller than the macromolecule, the fine components comprising salt components;
sensing the pH of the mixture;
controlling the pH of the mixture to between 6 to 8 by adding a pH buffer;
increasing the concentration of the macromolecule by at least 100% and decreasing the concentration of the salt components by at least 50% by:
applying the mixture, with a pressure differential, independently to each of at least two filters, the filters comprising:
a rough filter selected to remove at least a portion of rough components; and
a fine filter selected to remove at least a portion of fine components comprising salt components;
directing a desalination buffer through the fine filter into the mixture;
combining the macromolecule with a denaturation agent, and
heating the macromolecule and the denaturation agent until the macromolecule is substantially denatured.

45. The method of Claim 45, wherein the liquid mixture further comprises cells, further comprising lysing at least a portion of the cells by combining a lysis buffer with the cells.

46. An apparatus for preparing a macromolecule sample, comprising:

a hydraulic system adapted for control by an automated controller, comprising a pump and one or more valves;

a filter selected to separate, at least in part, a macromolecule in a liquid mixture from one or more salt components in the mixture; and

an automated controller that controls the pump and the valves.

47. The apparatus of Claim 47, further comprising a reservoir supplying a desalination buffer.

48. The apparatus of Claim 48, further comprising:

a reservoir supplying a denaturation agent; and

a heating element adapted for control by an automated controller.

49. The apparatus of Claim 49, wherein the filter is selected to separate components that have a molecular weight less than about 90% of the molecular weight of the macromolecule.

50. A method for preparing a macromolecule sample, comprising automatically:

acquiring a liquid mixture, the mixture comprising a macromolecule and one or more salt components;

separating the macromolecule from at least a portion of the salt components by applying the mixture to a filter with a pressure differential across the filter.

51. The method of Claim 51, further comprising reducing the concentration of the salt components by at least 75%

52. The method of Claim 52, further comprising controlling the concentration of the salt components by directing a desalination buffer through the filter into the mixture.

53. The method of Claim 53, further comprising increasing the macromolecule concentration by at least 200%.

54. The method of Claim 54, further comprising selecting the filter to separate the macromolecule from at least a portion of components that have a molecular weight less than about 90% of the molecular weight of the macromolecule.

55. The method of Claim 55, further comprising:

combining the macromolecule with a denaturation agent; and

heating the combined macromolecule and denaturation agent until at least partial denaturation of the macromolecule occurs.

56. An apparatus for preparing a macromolecule sample, comprising:

a hydraulic system adapted for control by an automated controller, comprising a pump and one or more valves;

a lysis unit that is capable of lysing cells in a liquid mixture comprising cells and a macromolecule; and

a filter selected to separate from the macromolecule, at least a portion of components in the mixture that are larger than the macromolecule, the components comprising insoluble lysed cell components; and

an automated controller that controls the pump and the valves.

57. The apparatus of Claim 57, wherein the molecular weight of the macromolecule is between 10,000 and 160,000 AMU.

58. The apparatus of Claim 58, wherein the lysis unit comprises a sonic disruptor.

59. The apparatus of Claim 58, wherein the lysis unit comprises a reservoir supplying a lysis buffer.

60. The apparatus of Claim 60, further comprising:
a reservoir supplying a denaturation agent; and
a heating element adapted for control by an automated controller.

61. The apparatus of Claim 61, wherein the filter is selected to remove insoluble components, further comprising a rough filter selected to separate from the macromolecule, at least in part, soluble components that have a molecular weight greater than about 110% of the molecular weight of the macromolecule.

62. A method for preparing a macromolecule sample, comprising automatically:
acquiring a liquid mixture, the mixture comprising a macromolecule and one or more cells;
lysing at least a portion of the cells; and
separating from the macromolecule at least a portion of components larger than the macromolecule, the components comprising insoluble lysed cell components, by applying the mixture to a filter with a pressure differential across the filter.

63. The method of Claim 63, further comprising lysing at least a portion of the cells by combining a lysis buffer with the cells.

64. The method of Claim 64 further comprising increasing the macromolecule concentration by at least 100%.

65. The method of Claim 65, further comprising increasing the macromolecule concentration by at least 200%.

66. The method of Claim 66, further comprising:

combining the macromolecule with a denaturation agent; and

heating the macromolecule and denaturation agent until at least partial denaturation of the macromolecule occurs.

67. The method of Claim 67, wherein the filter separates insoluble components, further comprising applying the mixture, to a rough filter with a pressure differential across the rough filter, the rough filter selected to separate soluble components that have a molecular weight that is greater than about 110% of the molecular weight of the macromolecule.

68. An apparatus for preparing a macromolecule sample, comprising:

means for automatically acquiring a liquid mixture, the mixture comprising a macromolecule, one or more rough components that are larger than the macromolecule, and one or more fine components that are smaller than the macromolecule; and

means for automatically separating from the macromolecule at least a portion of the components by applying the mixture to each of a plurality of filters, with a pressure differential across each filter, the filters comprising a rough filter selected to separate at least a portion of the rough components and a fine filter selected to separate at least a portion of the fine components.

69. An apparatus for preparing a macromolecule sample, comprising:

means for automatically acquiring a liquid mixture, the mixture comprising a macromolecule and one or more salt components;

means for automatically separating the macromolecule from at least a portion of the salt components by applying the mixture to a filter with a pressure differential across the filter.

70. An apparatus for preparing a macromolecule sample, comprising:

means for automatically acquiring a liquid mixture, the mixture comprising a macromolecule and one or more cells;

means for automatically lysing at least a portion of the cells; and

means for automatically separating from the macromolecule at least a portion of components larger than the macromolecule, the components comprising insoluble lysed cell components, by applying the mixture to a filter with a pressure differential across the filter.

71. An apparatus for preparing a macromolecule sample, comprising:

a hydraulic system comprising:

a plurality of valves;

a rough pump that draws a liquid mixture from a sample site through:

a first stage rough filter selected to separate rough components; and

a second stage rough filter selected to separate rough components that pass through the first stage rough filter;

a fine pump that:

draws a desalination buffer from a reservoir;

operates cooperatively with the rough pump to:

draw a portion of the liquid mixture through a fine filter, the fine filter selected to separate from the macromolecule fine components that have a molecular weight less than about 90% of the molecular weight of a macromolecule;

direct the desalination buffer through the fine filter to combine the desalination buffer with the macromolecule;

a denaturation pump that operates in combination with the rough pump to direct the macromolecule and the desalination buffer to a denaturing

vessel, the denaturing vessel comprising a heating element and a cooling element;

a reservoir supplying a denaturation buffer to the denaturation vessel;

a reservoir supplying a pH buffer;

a pH sensor located at the denaturization conduit;

an automated controller in electronic communication with the pumps, the denaturation vessel, and the sensor, that controls the apparatus to

acquire a liquid mixture from the sampling site, the mixture comprising a macromolecule, rough components, and fine components;

separate at least a portion of rough and fine components from the macromolecule;

combine a denaturation buffer with the macromolecule;

heat the denaturation buffer and the macromolecule in the denaturation vessel to denature the macromolecule;

control the pH of the mixture to between about 6 and about 8 by adding pH buffer to the mixture; and

direct the denatured macromolecule to the analysis site.